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Differential Effects of Tort Reform Across Medical Specialties

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DIFFERENTIAL EFFECTS OF TORT REFORM ACROSS MEDICAL SPECIALTIES

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Abstract

This paper utilizes data on physician malpractice insurance premiums and state tort law to analyze how physicians in various medical specialties are differentially affected by caps on noneconomic damages. As higher premiums put pressure on legislators to enact damage caps, I instrument caps on noneconomic damages with enactment of tort reform measures that do not affect malpractice premiums to uncover the effect of caps on noneconomic damages on such premiums. I find evidence to support that, in terms of dollars saved, physicians in high risk specialties benefit more from noneconomic damage caps than physicians in low risk specialties. However, in percentage terms, I find that physicians in all specialties essentially benefit equally from caps on noneconomic damages.

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1. Introduction

The rising costs of medical malpractice insurance have been the subject of much concern for the past three decades. In response to these steady escalations, state legislatures have passed numerous different tort reform measures, which attempt to reduce frivolous lawsuits and limit physician liability. A number of studies, discussed below, find that most of these reforms have unfortunately had little to no effect on medical malpractice premiums. However, caps on noneconomic damages, which limit the amount that a jury can award to a plaintiff in a medical malpractice case, have been shown to have a statistically significant effect in reducing medical malpractice premiums.

The purpose of this paper is to study the differences in premium reduction between medical specialties resulting from noneconomic damage caps, thereby limiting physician liability. My hypothesis is twofold: first, physicians in high risk specialties will benefit more than physicians in low risk specialties from capping noneconomic damage caps; second, in percentage terms, physicians in high and low risk specialties will see similar benefit from capping noneconomic damages. I find evidence to support my hypothesis that premiums, in dollar terms, for physicians in high risk specialties decrease more than physicians in low risk specialties in response to caps on noneconomic damages. In further support of my hypothesis, I find little difference, in percentage terms, in premium reduction between high risk and low risk physicians. In essence, these findings imply that, in response to caps on noneconomic damages, premiums in a given state decrease by a constant percentage for physicians in both high risk and low risk specialties. However, this percentage decrease corresponds to a higher dollar decrease for physicians in high risk specialties because their premiums are higher to begin with.

I proceed as follows: Section 2 discusses relevant literature, while Section 3 introduces a model of the medical malpractice insurance market and proposes a theoretical basis for my hypothesis that premiums will decrease more, in levels, for high risk physicians than for low risk physicians in response to reductions in liability and that, in percentage terms, premium decreases will be roughly equivalent across specialties. Section 4 discuses both data sources and the empirical model used to test my hypothesis. Section 5 discusses results and limitations. Section 6 concludes.

2. Relevant Literature

The literature on the effects of tort reform on medical malpractice premiums varies widely in its findings. In the early 1970's, the market for malpractice insurance experienced a number of problems; an ensuing insurance crisis severely limited the availability of malpractice insurance as insurers left that market in response to rapidly increasing liability risk. In an effort to mitigate the crisis, forty seven states passed a variety of medical malpractice tort reform measures[1]. Danzon (1986) empirically investigates the impact of these reforms on physician liability. Specifically, Danzon finds that damage cap rules and collateral source reforms both have significant effects on average malpractice payments. She finds that damage cap laws reduce average

[1] Brook et al. (1975) find that all states except Mississippi, Vermont, and Virginia enacted some form of tort reform in the mid 1970's.

malpractice payments by 23% and collateral source reforms reduce average malpractice payments by around 11% to 18%. However, Danzon finds that other forms of tort reform have no significant effect on physician liability risk.

Sloan et al. (1989) conduct a similar investigation, examining the effects of various tort reform measures on both average malpractice payments and the probability of being liable for a malpractice payment. They look at a number of different reform measures: damage caps, collateral source reform, and periodic payment reforms. In line with Danzon's (1986) findings, they find that caps on damages, both total damages and noneconomic damages, have extremely significant and economically important effects on average indemnity payments; however, they also find that neither of these caps have any statistically significant effect on the probability of a malpractice payment. In line with the conventional wisdom, they find that caps on punitive damages have no statistically significant effect on average malpractice payments. Further, they find that collateral source reform lowers average malpractice payments. Finally, they find that periodic payment reform has no significant effect on the average malpractice payment size.

In a similar investigation, Barker (1992) uses statewide loss-ratios to investigate the effects of various tort reform measures on total liability risk. She finds that the caps on damages are the only tort reform measure to have statistically significant effects on liability risks. She also finds that strictly codifying the required standard of care has a beneficial effect on liability risk.

The mid 1980's had a similar malpractice insurance crisis and a large number of states passed a second wave of tort reform measures in attempts to curb rapidly escalating premiums. Whereas the 1970's "crisis of availability" was marked by insurers leaving the market, the 1980's "crisis of affordability" was marked by skyrocketing premiums. While Viscusi et al. (1993) find that some reforms lowered premiums for general liability insurance, they find that most reform measures passed during this period had little effect on premiums for medical malpractice insurance. They find that modifications to joint and several liability have a statistically significant effect of reducing premiums. However, they find that no other reforms (including limits on damages) have any significant effects on premiums.

3. Model

3.1 The General Model

The market for medical malpractice insurance is unusual in that, unlike most other types of liability insurance, firms do not experience rate, i.e. they do not factor in past claims history when determining premiums for individual physicians. Hence, premiums for physicians of a given specialty, state, and region are identical, leading to a large amount of within-specialty cross subsidization. Peculiarly, physicians have been vehemently against attempts by state legislatures and insurance companies to experience-rate premiums.

In this section I present a model of how limiting liability differentially affects physicians across specialties. Specifically, the model illuminates the medical malpractice insurance market's response to enactment of liability limiting tort reform measures;

further, it details how these market shifts affect physicians in high risk specialties versus physicians in low risk specialties. My model of the insurance industry assumes there are only two specialties, one with high probability of being sued for malpractice and one with low probability of being sued for malpractice. Second, I assume that physicians of both specialties have identical incomes as allowing for differences in incomes does not change any of the conclusions. Third, I assume that, conditional on being sued for malpractice, expected indemnity payments are homogenous across the two specialties. This is consistent with Jena et al. (2011)[2] who find that there are not large differences in indemnity payments across specialties. Fourth, I assume that the distribution of indemnity payments is also identical across the two specialties. Finally, there are only two periods in the model. Let W_1 and W_2 denote physician income and physician income less the expected indemnity payment, respectively. Let x and y represent the initial levels of W_1 and W_2, respectively; let p_h and p_l denote the group probability of being successfully sued for malpractice for high and low risk physicians, respectively. Further, we know that, in the absence of asymmetric information, physicians will purchase full

[2] Until recently, despite the tremendous amount of research that's been done in the area of medical malpractice, there has been relatively little estimation of the true risk of malpractice for physicians in specific specialties. Jena et al. (2011) use physician level malpractice claim data to determine the relative risks between physician specialties. They estimate that the risk of having a malpractice claim is almost 20% for some surgical specialties as compared to only 2.6% in psychiatric professions. Interestingly, the median amount awarded to a claimant was not highly correlated with the likelihood of receiving a claim. Furthermore, the average amount of a malpractice payment was fairly constant across specialties. Hence, conditional on being found guilty of malpractice, liability risk does not differ across specialties. This somewhat surprising finding will be a key assumption in the models that follow in this section.

insurance (Rothschild Stiglitz, 1976). The absence of asymmetric information problems is justified in the succeeding section. Hence, at equilibrium, the levels of W_1 and W_2 for high risk physicians are given by the following two equations:

$$(W_2 - y) = \frac{-(1-p_h)}{p}(W_1 - x)$$

$$W_2 = W_1$$

Hence, $W = (1 - p_h)x + yp_h$

Similarly for low risk physicians:

$$(W_2 - y) = \frac{-(1-p_l)}{p}(W_1 - x)$$

$$W_2 = W_1$$

Implying, $W = (1 - p_l)x + yp_l$

Given all this, the two insurance markets for the high and low probability specialties look as such:

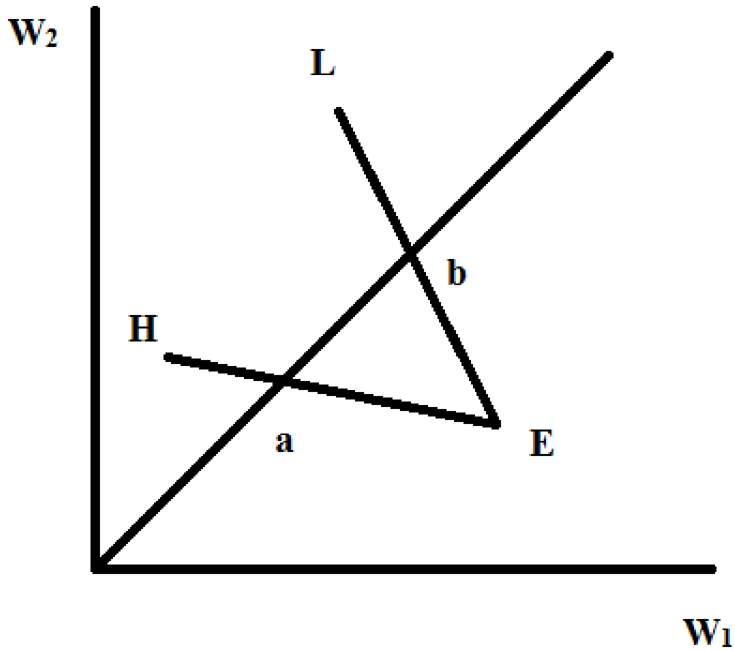

Figure 1

Point E is the level of wealth in each state without insurance, point a is the full insurance level of W_1 and W_2 for high risk physicians and point b is the full insurance level of W_1 and W_2 for low risk physicians. Line EH is the fair odds line for high risk physicians and line EL is the fair odds line for low risk physicians.

This model can be readily used to examine the effects of laws that limit liability in medical malpractice suits. One example of such a law is a cap on the amount of noneconomic damages that can be awarded to a plaintiff. First, note that such a change will have a negligible effect on the probabilities of being sued for both specialties as presumably a patient will still file a suit if they have been wronged and law changes have no effect on the intrinsic probability that a physician will make a mistake. Next, these law changes will have no effect on the starting level of W_1, the physician's level of income without insurance. Thus, the only effect that capping economic damages will have is to increase the level of W_2 for all specialties as their expected loss in the event of a malpractice suit has diminished. Further, under the assumption that the distribution of indemnity payments is identical for the two specialties, W_2 will increase by the same amount for both specialties. Hence, the shifts in the two insurance markets look like such:

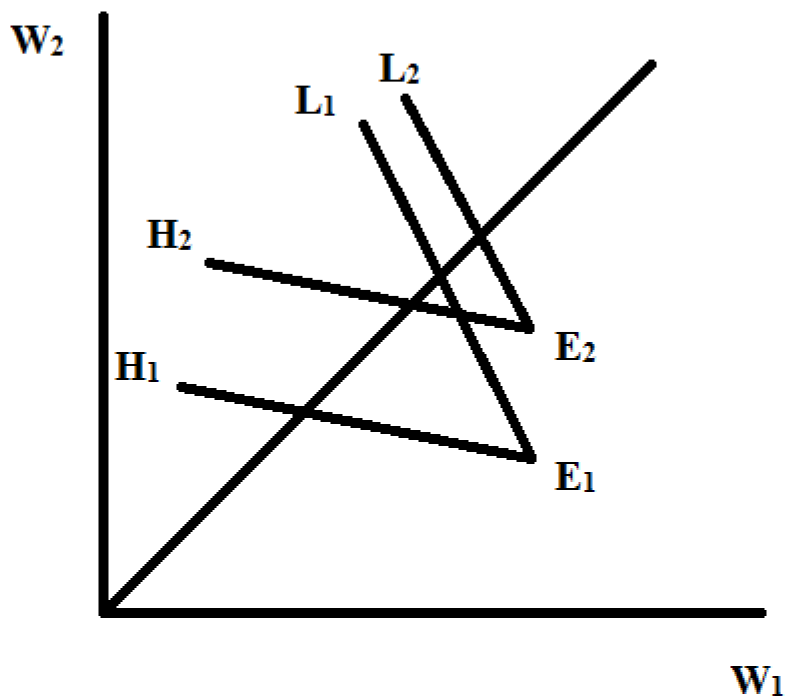

Figure 2

In Figure 2, line E_1H_1 denotes the fair odds line for the high risk physicians before a law change and line E_2H_2 denotes the fair odds line for the high risk physicians after a law change; line E_1L_1 denotes the fair odds line for the low risk physicians before a law change and line E_2L_2 denotes the fair odds line for the low risk physicians after a law change.

Importantly, this shift in liability does not affect all physicians equally. The full insurance level of wealth, which is the intersection of the respective fair odds line with the 45° line, for high risk physicians has increased dramatically whereas the full insurance level of wealth for low risk physicians has only increased moderately. Specifically, we know that the slope of the fair odds line is $\frac{-(1-p_i)}{p_i}$, where i denotes specialty, and that physicians will purchase full insurance. From above, we know that in equilibrium the following equation is satisfied, where the i index denotes specialty:

$$W_i = (1 - p_i)x + yp_i$$

When damage caps are enacted y is increased by δ for all specialties as wealth conditional on being sued is now higher. This implies:

$$\Delta W_i = \delta p_i$$

Clearly, ΔW is increasing in p. Hence, following a given decrease in liability, physicians with higher probabilities of being sued have a higher increase in their wealth level under full insurance than do physicians with lower probabilities of being sued.

In this model insurance premiums are the decrease in W_1 required to set $W_1 = W_2$, i.e., $Premium_i = W_i - x$. Hence, $\Delta Premium_i = \Delta W_i = \delta p_i$. As such, I expect that changes in liability will have greater effects on premiums for physicians in high risk specialties. However, the story is slightly different in percentage terms. The percentage change in premiums is given by the change in premiums divided by the premiums before tort reform:

$$\%\Delta Premium_i = \frac{\Delta Premium_i}{Pre - Reform\ Premium_i} = \frac{\delta p_i}{(1-p_i)x + yp_i - x} = \frac{\delta}{y-x}$$

Note that the $\%\Delta Premium$ is independent of specialty; hence I expect that, in percentage terms, premiums for physicians in high risk specialties will decrease by about the same amount as premiums for physicians in low risk specialties. Accordingly, I expect tort reform laws that limit physician liability will decrease the difference between premiums for high risk physicians and premiums for low risk physicians, but percentage decreases across specialties should be roughly equivalent. Intuitively, capping noneconomic damages leads firms to cut premiums by a constant percentage for physicians in all specialties; however, this constant percentage decrease yields a higher decrease, in levels, for physicians in high risk specialties as their premiums are higher to begin with.

The model shows that in a Rothschild-Stiglitz framework physicians with a high risk of being successfully sued for malpractice benefit to a greater extent, in levels, from liability limiting tort reform measures than do physicians in low risk specialties. However, in percentage terms, physicians in different specialties benefit to a similar extent to liability limiting tort reform measures. In the next section I will test this prediction using data on physician premiums and tort reform enactments by state.

3.2 *Justification for Ignoring Asymmetric Information*[3]

One key potential limitation of the above model is that it ignores asymmetric information. Physician's preferences for an absence of experience rating at first seems inconsistent with the fact that prediction that experience rating would lead to expected gains for the vast majority of physicians (Fournier and McInnes, 2001)[4]. However, by

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[3] The logic of this model follows directly from the classic Rothschild-Stiglitz (1976) model. Rothschild and Stiglitz show that if consumers differ in their probability of requiring an insurance payout, consumers are aware of their own probabilities of requiring such a payout, and that insurance companies are unable to tell the difference between individuals with high probabilities and low probabilities, pooling equilibria, in which everyone purchases the same insurance contract, cannot exist in a competitive market. They show that under certain market compositions (of high and low probability individuals), separating equilibria, whereby high probability individuals buy one contract and low probability individuals buy a separate insurance contract, can actually exist. Rothschild-Stiglitz further notes that in this scenario, high risk individuals are a purely negative externality on low probability individuals: by not revealing their "type" they make low risk individuals worse off without making themselves any better off. However, they also posit that under other market compositions, it's possible that no equilibrium exists. Finally, they go on to show that their results are not entirely dependent on the assumption that individuals are fully aware of their risk profiles, but rather that there exists some characteristic that distinguishes the insurance preferences of low and high risk individuals.

[4] A number of other works have studied the deterrent effect of medical malpractice insurance. Fournier and McInnes (2001), Phelps (1978), and Rolph (1981) all find that an extremely disproportionate number of claims are filed against a very small percentage of physicians. All three of these studies mention that premiums would likely be greatly increased (to the extent of pushing them out of the market), thereby removing the negligent physicians from the healthcare industry. Hence, not only will experience rating reduce cross-subsidization, leading to relatively large decreases in premiums for the majority of physicians,

refusing to accept experience rating, physicians are essentially purchasing insurance on their insurance, which makes sense under a certain set of conditions. Consider the following three period model for a physician in a given specialty. In the first period the physician does not know whether he/she will be a high-risk individual or a low-risk individual and he/she has to decide at this point whether he/she will enter into one of two scenarios: buy insurance with other physicians of the same specialty at the same group rate or be differentiated by experience (again within specialty) in the coming periods and charged rates based on past performance. During the second period there is no experience to base premiums off of; hence, all physicians are charged the same group rate determined by their collective probability of having a claim filed against them. Further, during the second period each physician has some individual probability p of having a claim filed against them. Finally, during the third period, physicians who entered into the first scenario of group rates are again charged a rate determined by their collective probability of having a claim filed against them (leaving them with some level of wealth c); however, physicians who chose to allow their premiums to depend on experience have expected wealth of $p*a + (1-p)*b$, where a is his/her level of wealth under full insurance conditional on having a claim filed against him/her in period 2 and b is his/her level of wealth under full insurance conditional on not having a claim filed against him/her in

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but it will also have the added positive societal effect of removing bad physicians from the market. Further, Sloan (1990) notes that it's pertinent not to go overboard with experience rating or one runs the risk of too much risk-classification error; he notes that one can mitigate this risk by using other non-experience classification criteria.

period 2. This is depicted graphically below in Figure 3, where E is the physician's level of wealth without insurance, W_1 is income and W_2 is income less the expected loss in the event of a malpractice suit. Line EP denotes the pooled fair odds line, line EH denotes the high risk experience rated fair odds line and line EL denotes the low risk experience rated fair odds line. By overwhelmingly opting for the pooled scenario, physician's reveal their preferences as such: $U(c) > p * U(a) + (1 - p) * U(b)$, where $U(\cdot)$ denotes physician utility of a given level of wealth. However, this aversion to premium risk comes at a cost as $pa + (1 - p)b$ is greater than c (Fournier and McInnes, 2001). By opting for the pooling scenario, physicians subject themselves to within-specialty cross-subsidization which results in lower expected wealth than the experience rating scenario. They're willing to take this loss and buy insurance on their insurability given their risk aversion arising from their uncertainty as to their own individual risk probability. Hence, in the presence of experience rating the predictions of the model are similar regardless of the presence of asymmetric information.

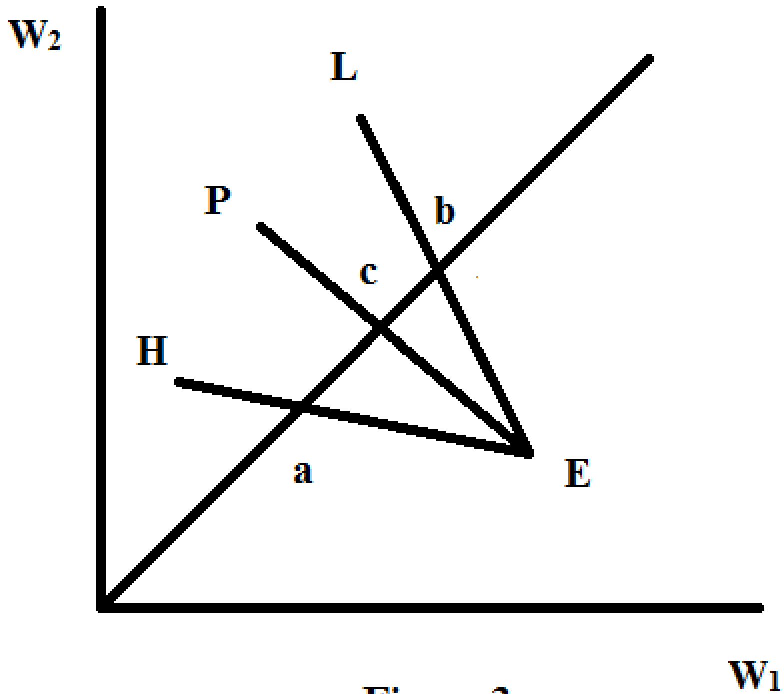

Figure 3

4. Data & Estimation

The model outlined in the last section leads to an important testable hypothesis: liability limiting tort reform measures should decrease premiums for physicians of all specialties, but this decrease should be greater, in levels, for physicians in high risk specialties relative to physicians in low risk specialties. However, in percentage terms, this decrease should be roughly equivalent across specialties.

4.1 Data

To test this hypothesis I compile a dataset comprising data on effective state tort reforms, state demographic factors, and premium data by firm for physicians in three different specialties: internal medicine (a catchall for general practitioners), general surgery, and OB/GYN's. The data on state level tort reform measures was compiled by Ronen Avraham and records the effective date of the ten most prevalent kinds of tort reform measures for all 50 states and the District of Columbia from 1980 to 2010. All of the reforms are coded as indicator variables for their effective years, hence the data do not differentiate between caps on noneconomic damages of $100,000 and caps of noneconomic damages of $500,000. It's also noteworthy to mention that the database does not include reforms that were overturned within three years of passage. The five different variables that I use from this dataset are caps on noneconomic damages, caps on punitive damages, punitive evidence reforms, split recovery reform, and contingency fee reforms.

My data on premiums comes from an annual survey done by Medical Malpractice Monitor. The survey collects data on the premium for a hypothetical policy that offers $1 million in coverage per claim and $3 in coverage per year. The data provides information at the state, region, firm, and specialty level for three different specialties: internal medicine, general surgery, and obstetrics-gynecology (OB/Gyn's). For example, the data provide us with the premium offered to an OB/Gyn in San Diego by the Doctor's Company in 1995. I first use average premiums for a given state, year, and specialty as my dependent variable and then use premiums at the state, year, specialty, firm level as my dependent variable. Both specifications yield similar results.

I also use data from the Area Resource File (ARF), which is a comprehensive database of over 6,000 county specific demographic and medical variables. After aggregating these data up to the state level, I use a number of different items as control variables: number of births, number of hospitals, number of hospital admissions, number of surgeries, average income, and population. The population numbers, while contained in the ARF, are numbers from the Census Bureau.

The data for all of these variables is available for the period 1993-2004. Summary statistics for the various variables are presented in Table 1.

Table 1 – Summary Stats of Average Premiums

VARIABLES	(1) mean	(2) N	(3) sd
AvgPremium_Internal_Medicine	8,051	590	5,299
AvgPremium_General_Surgery	27,849	590	17,238
AvgPremium_OBGYN	45,192	590	25,401
Premium_Internal_Medicine	10,727	2,530	8,163
Premium_General_Surgery	35,627	2,527	26,371
Premium_OBGYN	55,599	2,526	34,825
Noneconomic Damages Cap	0.227	612	0.419
Punitive Damages Cap	0.363	612	0.481
Split Recovery Reform	0.098	612	0.298
Punitive Evidence Reform	0.647	612	0.478
Contingency Fee Reform	0.353	612	0.478
Population (millions)	5.443	612	6.029
Hospitals	143.8	612	138.0
Admissions	795,440	612	898,119
Births	88,394	612	117,350
Surgeries	494,280	612	481,292
Average State Income	26,211	612	5,720

4.2 Estimation

Jena et al. (2011) provide evidence that the probability of having a successful malpractice claim filed against a physician practicing internal medicine is significantly lower than the corresponding probability for both surgeons and OB/Gyn's. As such, I expect that enactment of tort reform measures will have significantly greater effects, in levels, on the premiums of surgeons and OB/Gyn's than for physicians in internal medicine. Again, I expect that, in percentage terms, enactment of tort reform measures will have equivalent effects on the premiums for OB/Gyn's, surgeons, and physicians in internal medicine.

In particular, I examine the effects of caps on noneconomic damages on premiums across specialties. Caps on noneconomic damages should reduce liability risk for physicians of all specialties. Further, under the assumptions introduced in the model of the medical malpractice insurance market above (namely that the distribution of indemnity payments is identical across specialties), these caps should reduce liability risk by the same amount. The equation of interest is thus:

$$y_{ikt} = \beta(Specialty \cdot x_{it})a + \delta_t + \mu(Specialty \cdot \theta_{it}) + \varepsilon_{ikt}$$

In the above equation, y_{ikt} represents medical malpractice premiums for a given state (i), specialty (k) and time (t); I use premiums at both the average state, year, specialty level as well as at the state, year, firm, specialty level. x_{it} is a binary variable indicating whether or not a given state at a given time has enacted a cap on noneconomic damages in medical malpractice cases. δ_t are time fixed-effects and θ_{it} is a vector of state demographic factors including income, population, number of hospitals, etc. Further, I allow the effects of all of these variables to vary by specialty. Notably, state fixed-effects are absent from this model. This absence has been necessitated by the lack of within-state variation of these laws over time. The impact of unobserved state specific omitted variable bias is mitigated[5] by the fact that the model is estimated using the differential effect of caps on noneconomic damages between specialties and not the magnitude of this effect for any one specialty's premiums. Finally, it must be noted that using firm level premiums as the dependent variable, there are often multiple firms offering slightly different rates within the same state (or even multiple firms offering slightly different rates across various regions of the same state). As I'm not seeking to illustrate within-state differences, I ignore this as it can be viewed simply as measurement error in the dependent variable, which will not bias coefficient estimates or standard deviations.

The results from running a simple OLS regression on the data are shown in Table 2. The magnitude of each coefficient is relatively small and statistically significant, i.e., there is no evidence for differences in premium reduction, in either levels (1) or percentages (2), between physicians in internal medicine, surgeons, and OB/Gyn's in response to capping noneconomic damages. While at first this may seem to contradict my hypothesis, the coefficients on Noneconomic Damage Caps for the three respective specialties are almost certainly contaminated by endogeneity bias. In particular, states with high medical malpractice insurance premiums are more likely to pass caps on noneconomic damages, which limit physician liability and thereby lower premiums. For example, Avraham et al. (2009) suggests that "[it's a possibility] that changes in

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[5] Specifically, I assume that state fixed-effects would merely shift responses up or down equally for all specialties. While I can't test this assumption, it's necessary and reasonable.

premiums prompt the passage of laws rather than vice versa." Sloan et al. (1989) and Danzon (1986) both note that in both the 1970's "crisis of availability" and the 1980's "crisis of affordability" political pressures surrounding increasing liability risk prompted passage of tort reform measures. Given that in these two cases higher premiums certainly caused attempts to limit physician liability, it's very likely that escalating premiums prompted legislators to pass tort reform measures in my sample period, 1993-2004.

Table 2 – OLS Estimates

VARIABLES	(1) Premium	(2) LogPremium
Noneconomic Damages Cap	-831.0	-0.00353
	(522.0)	(0.0397)
General Surgery*r_cn	2,453	0.0267
	(1,784)	(0.0571)
OB/Gyn*r_cn	900.0	0.0280
	(2,202)	(0.0556)
Constant	3,414	-3.626**
	(2,162)	(1.448)
Observations	1,770	1,770
R-squared	0.654	0.741

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To deal with the endogeneity problem, I instrument caps on noneconomic damages with other tort reform measures which I expect to have little or no effect on liability risk and which, in particular, I expect would not be passed in response to high premiums. Rather, I view these reforms as indicative of the general attitude towards tort reform measures and in that sense correlated with the passage of caps on noneconomic damages, which I assume are passed for the sake of limiting physician liability not simply as a result of general fervor for tort reform.

The general idea behind the instrumental variables specification then is to first measure the tort reform climate in a given state using non-liability-limiting laws and then measure the effect of capping noneconomic damages, which limits liability, in the absence of pressure to lower premiums. The four types of non-liability-limiting reforms that I use as instruments are split recovery reforms, caps on punitive damages, punitive evidence reforms, and contingency fee reforms. Table 3 lists a number of laws and the states which had this law in effect at any time during the sample period, 1993-2004.

Table 3 – Law Prevalence

Law	State
Caps on Noneconomic Damages	CA, CO, FL, HI, ID, KS, MD, MS, MO, MT, NV, ND, OK, OR, SD, TX, UT, WV, WI
Split Recovery Reform	AK, FL, IN, IA, OR, PA, UT
Caps on Punitive Damages	AL, AK, CO, GA, ID, IL, IN, KS, LA, MI, NE, NV, NH, NJ, NC, ND, OK, OR, PA, VA, WA, WI

Punitive Evidence Reform	AL, AK, AZ, AK, CA, CO, DE, D.C., FL, GA, HI, ID, IN, IA, KS, KY, ME, MD, MN, MS, MO, MT, NE, NJ, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, WI
Contingency Fee Reform	CA, CT, DE, FL, HI, IL, IN, ME, MA, MI, NH, NJ, NY, OK, TN, UT, WI, WY
Illegal to Insure against Punitive Damages	CA, CO, CT, FL, IL, IN, KS, MA, ME, MN, NE, NJ, NY, OK, PA, RI, UT

Split recovery reforms are a type of tort reform measure that mandate that a certain percentage of punitive damage awards are granted not to the plaintiff or the plaintiff's estate, but rather to a state fund. These sorts of reforms do not affect the liability of the physician (and hence should not affect premiums), but rather affect the distribution of money after an indemnity payment has been made. However, enactments of split recovery reforms should be correlated with enactment of caps on noneconomic damages as they reflect the general attitude towards tort reform within a state.

The second and third instruments I use are caps on punitive damage awards and punitive evidence reform; the former refers to capping damages that are assessed as a form of punishment for gross negligence or intentional malicious conduct and the second refers to upping the evidence required to assess punitive damages. Firstly, caps on punitive damages are usually enacted to help businesses rather than physicians; according to The Doctor's Company, a large U.S. insurer, "It is uncommon to see punitive damages in medical malpractice cases, but it is not unprecedented." Furthermore, a large number of states have laws specifically mandating that insurance companies are not allowed to sell insurance on punitive damages. Further, even if punitive damages are legally insurable many insurance policies do not cover them (McCullough, Campbell, and Lane, LLP). The argument against using caps on punitive damages and punitive evidence reform is essentially that while these damages are by and large not insurable, either by law or by custom, they affect the bargaining power of the plaintiff in the case of a settlement, thereby increasing physician liability[6]. However, given the rarity of actually seeing punitive damages awarded in medical malpractice suits, this extra bargaining power is sufficiently negligible in the sense that states are not passing punitive damage reforms specifically to lower premiums. Under this assumption and the fact that caps on noneconomic damages are passed for the purpose of lowering premiums, both caps on punitive damages and punitive evidence reform are valid instruments.

The last instrument I use for caps on noneconomic damages is contingency fee reform. Contingency fee reform is a type of law that limits the percent of an indemnity payment that can be paid to the lawyer in the event that the lawyer is working on a contingency basis. For example, such a law may mandate lawyers may recover no more than 40% of the total value of an indemnity payment. The idea behind using contingency fee reform as an instrument is that these law changes will not affect premiums to the extent that they would be passed in response to high premiums. In fact, under a simple assumption (if lawyers take on no fewer medical malpractice cases after a contingency

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[6] Malani and Reif (2010) find evidence that caps on punitive damages have significant effects on medical malpractice premiums. To deal with this potential criticism, I re-estimate my model restricting the sample to states in which it is illegal for physicians to purchase insurance against punitive damages.

fee reform than they did before the reform), such changes will have no effect on premiums. The argument against using contingency fee reforms as an instrument is essentially that some cases will no longer be profitable for attorneys to take on; hence, such a reform could be passed in an attempt to limit premiums. I claim that at worst the effect of such a reform would be to remove just the cases with the very smallest (expected) payouts and hence would not be used by legislators to drastically reduce insurance premiums for physicians. However, for the sake of robustness I run the instrumental variables regression using contingency fee reforms as an instrument and I run the same regression omitting contingency fee reform, it does not dramatically change the results.

I then estimate the following two stage least squares regression:

$$y_{ikt} = \beta(\widehat{Specialty \cdot x_{it}}) + \delta_t + \mu(Specialty \cdot \theta_{it}) + \varepsilon_{ikt}$$

5. Results

5.1 Average Premiums as Dependent Variable

As discussed in Section 4, I use two different dependent variables to test for robustness: premiums at the year, state, specialty, firm level and average premiums for a given year, state, and specialty. I first discuss the results using average premiums for a given year, state, and specialty as the independent variable. The first stage regressions are presented in Table 4[7] below. The coefficients on the various law changes in Table 4 can be interpreted as a percentage increase in the probability that noneconomic damage caps are enacted for physicians in internal medicine (1), general surgery (2) and OB/Gyn's (3). For each of the three first stage regressions, Specialty*punitive evidence reform is individually significant. Further, the instruments pass a weak instruments test for each of the three first stage regressions: for (1), $F(12,1726) = 36.28$, $p=0.00$, for (2), $F(12,1726) = 13.43$, $p=0.00$, for (3), $F(12,1726) = 13.43$, $p=0.00$.

The results for the coefficients of interest for the instrumental variables regression are displayed in the first column of Table 5. All standard errors reported are bootstrapped standard errors to remove autocorrelation and heteroskedasticity. The base group for all of the regressions in Table 5 is the internal medicine specialty, thus all terms containing a dummy variable for internal medicine physicians have been removed. As such, in column 1 the coefficient on caps on noneconomic damages represents the exogenous effect of a cap on noneconomic damages on premiums for physicians in internal medicine. The coefficient on caps on noneconomic damages is roughly -5,000, implying that caps on noneconomic reduce premiums for physicians in internal medicine by about $5,000 on average. Further, this coefficient is highly statistically significant. Of much greater importance, however, are the coefficients on the interaction terms representing the differential effect of noneconomic damage caps for surgeons and OB/Gyn's. The coefficients on these two terms are approximately -7,000 and -20,000 which denotes

[7] Note that these are the first stage regression for the level specification. The first stage regression for the log specification are highly similar and the instruments pass weak instrument tests in both cases. Further, I've removed values whose coefficient was 0 and extremely insignificant to enhance readability. To ensure consistency all regressors were included in each first stage regression.

Table 4 – First Stage regressions

VARIABLES	(1) Noneconomic Damage Caps	(2) Noneconomic Damage Caps _General_Surgery	(3) Noneconomic Damage Caps _OBGYN
Punitive Evidence Reform	0.316***	-0.00176	-0.00176
	(0.0273)	(0.00160)	(0.00160)
General Surgery*Punitive Evidence Reform		0.321***	
		(0.0274)	
OB/Gyn*Punitive Evidence Reform			0.321***
			(0.0274)
Punitive Damages Cap	0.0504	0.000756	0.000756
	(0.0332)	(0.00144)	(0.00144)
General Surgery*Punitive Damages Cap		0.0481	
		(0.0334)	
OB/Gyn*Punitive Damages Cap			0.0481
			(0.0334)
Split Recovery Reform	-0.00281	-0.00318	-0.00318
	(0.0583)	(0.00242)	(0.00242)
General Surgery*Split Recovery Reform		0.00675	
		(0.0582)	
OB/Gyn*Split Recovery Reform			0.00675
			(0.0582)
Contingency Fee Reform	0.0387	0.00387	0.00387
		(0.00244)	(0.00244)
General Surgery*Contingency Fee Reform		0.0271	
		(0.0365)	
OB/Gyn*Contingency Fee Reform			0.0271

			(0.0365)
Constant	0.199**	0.0509*	0.0509*
	(0.0947)	(0.0301)	(0.0301)
Observations	1,770	1,770	1,770
R-squared	0.233	0.357	0.357

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

that, on average, caps on noneconomic damages decrease premiums by \$7,000 and \$20,000 *more* than for physicians in internal medicine, for surgeons and OB/Gyn's, respectively. While the coefficient on the interaction term for surgeons in not statistically significant, the large difference between changes in premiums for OB/Gyn's and physicians in internal medicine is highly statistically significant, implying that premiums for OB/Gyn's respond more to capping noneconomic damages than do premiums for physicians in internal medicine.

Finally, I do a Sargan-Hansen test of the overidentifying restrictions. The joint null hypothesis of this test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation, $\chi^2(9) = 21.801$, $p = .01$; hence, I cannot reject the null hypothesis that the instruments are valid.

The third column of Table 5 shows the same regression without using contingency fee reforms as an instrument. The results are almost identical. The differential effects of damage caps between OB/Gyn's and physicians in internal medicine are still statistically significant at the 1% level. Again I test overidentifying restrictions, $\chi^2(6) = 16.622$, $p = .01$. While I believe that the inclusion of contingency fee reforms as an instrument is appropriate given the arguments above, the results do not change significantly when it is excluded as an instrument.

These results provide evidence for part of the initial hypothesis: caps on noneconomic damages, which mitigate physician liability risk, will have greater effects on premiums for physicians in high risk specialties (OB/Gyn's) relative to physicians in low-risk specialties (internal medicine).

Table 5 – IV Estimates

VARIABLES	(1) AvgPremium	(2) LogAvgPremium	(3) AvgPremium	(4) LogAvgPremium
Noneconomic Damages Cap	-4,989***	-0.609***	-5,397***	-0.667***
	(1,739)	(0.158)	(1,636)	(0.168)
General Surgery*Noneconomic Damages Cap	-6,667	-0.0519	-6,433	0.0164
	(4,609)	(0.224)	(4,620)	(0.231)
OB/Gyn*Noneconomic Damages Cap	-19,760***	-0.0723	-19,566***	-0.0367
	(6,879)	(0.218)	(6,386)	(0.239)
Constant	7,334***	-3.943**	7,502***	-1.128
	(2,711)	(1.622)	(2,523)	(1.112)
Observations	1,770	1,770	1,770	1,770
R-squared	0.577	0.661	0.575	0.654

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Next, I ran the same regressions using a log specification to test whether the same differential effects were observed in percentage terms. These two regressions are presented in columns 2 and 4 of Table 5, corresponding to the specification including contingency fee reforms and excluding contingency fee reforms, respectively. In accordance with my hypothesis, there is little evidence that there is a differential effect of damage caps between surgeons or OB/Gyn's and physicians in internal medicine in percentage terms. The percentage effects of damage caps range from decreasing premiums by 46% to 50%; however, there is no statistically significant difference of this effect between surgeons or OB/Gyn's and physicians in internal medicine. Finally, I ran tests of the overidentifying restrictions: for (2) $\chi^2(9) = 24.764$, $p = .00$, and for (4) $\chi^2(6) = 18.368$, $p = .01$.

I noted in the previous section that there are arguments for why both punitive evidence reforms and caps on punitive damages are not good instruments. However, there are 17 states that have laws specifically prohibiting insurance companies from insuring physicians against punitive damages. As such, I run the same instrumental variables regressions as above, omitting contingency fee reforms and restricting the sample only to states that prohibit insuring against punitive damages. The IV estimates for the level (1) and log (2) specifications are shown in Table 6 below[8]. The results are similar to the unrestricted sample - the differential effects of damage caps between OB/GYN's and physicians in internal medicine are slightly higher, but are still statistically significant at the 1% level. Finally, I run Sargan-Hansen tests on the

[8] First stage regressions aren't shown but all first stage regressions passed weak instrument tests.

overidentifying restrictions, for (1) $\chi^2(6) = 9.771$, p = .13, and for (4) $\chi^2(6) = 17.235$, p = .01.

Table 6 – IV Estimates

VARIABLES	(1) AvgPremium	(2) LogAvgPremium
Noneconomic Damages Cap	-11,458***	-0.394
	(4,394)	(0.276)
General Surgery*Noneconomic Damages Cap	1,256	-0.149
	(7,637)	(0.337)
OB/Gyn*Noneconomic Damages Cap	-26,990**	-0.460
	(10,594)	(0.368)
Constant	25,697***	-1.376
	(7,862)	(2.854)
Observations	582	582
R-squared	0.538	0.714

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In summary, while I do not find evidence to support the claim that, in percentage terms, premiums by specialty respond differently to laws mitigating liability risk, I find evidence to support that, in levels, premiums by specialty do respond differently to laws mitigating liability risk. Both of these findings are consistent with the theoretical model proposed in Section 3. Hence, there are two conclusions worth stating here: first, limiting physician liability through damage caps does reduce premiums; second, in terms of dollars saved, physicians in high risk specialties benefit more, in terms of dollars paid in premiums, from those reforms than do physicians in low risk specialties.

5.2 Firm Level Premiums as Dependent Variable

Next I look at the same set of IV regressions using firm level premium data as the dependent variable. The first stage regressions are reported below in Table 7[9]. The coefficients on the various law changes in Table 7 can be interpreted as a percentage increase in the probability that noneconomic damage caps are enacted for physicians in internal medicine (1), general surgery (2) and OB/Gyn's (3). Importantly, the instruments pass a weak instruments test for each of the three first stage regressions: for (1), F(12,7557) = 165.13, p=0.00, for (2), F(12,1726) = 61.21, p=0.00, for (3), F(12,7557) = 61.17, p=0.00.

I present the results for the coefficients of interest for the instrumental variables regression in Table 8. All standard errors reported are bootstrapped standard errors to remove autocorrelation, heteroskedasticity, as well as errors correlation within groups of firms offering insurance to physicians of the same specialty in the same year and state. All four regressions are tested for overidentifying restrictions: for (1) $\chi^2(9)$ = 324.4.06, p = .00, and for (2) $\chi^2(6)$ = 169.896, p = .00, for (3) $\chi^2(9)$ = 286.200, p = .00, and for (4) $\chi^2(6)$ = 240.793, p = .00. Again, the base group for all of the regressions in Table 8 is the internal medicine specialty. The results are fairly similar to the results using the average statewide premiums in Section 5.1. The important coefficient in this table is that on OB/Gyn*Noneconomic damages, which

[9] Note that these are the first stage regression for the level specification. The first stage regression for the log specification are highly similar and the instruments pass weak instrument tests in both cases. Further, I've removed values whose coefficient was 0 and extremely insignificant to enhance readability. To ensure consistency all regressors were included in each first stage regression.

Table 7 – First Stage Regressions

VARIABLES	(1) Noneconomic Damage Cap	(2) Noneconomic Damage Cap_General_Surgery	(3) Noneconomic Damage Cap_OBGYN
Punitive Evidence Reform	0.295***	0.00227**	0.00227**
	(0.0141)	(0.000912)	(0.000912)
General Surgery*Punitive Evidence Reform	0.000775	0.289***	3.34e-05
	(0.0199)	(0.0142)	(0.00109)
OB/Gyn*Punitive Evidence Reform	0.000675	2.79e-05	0.289***
	(0.0199)	(0.00109)	(0.0142)
Punitive Damages Cap	-0.0415***	-0.000466	-0.000469
	(0.0158)	(0.000861)	(0.000861)
General Surgery*Punitive Damages Cap	-0.000473	-0.0406**	-1.93e-05
	(0.0223)	(0.0158)	(0.00104)
OB/Gyn*Punitive Damages Cap	-0.000329	-1.18e-05	-0.0405**
	(0.0223)	(0.00104)	(0.0158)
Split Recovery Reform	-0.0624**	-0.00355**	-0.00355**
	(0.0258)	(0.00175)	(0.00175)
General Surgery*Split Recovery Reform	-0.000785	-0.0525**	-3.50e-05
	(0.0362)	(0.0259)	(0.00167)
OB/Gyn*Split Recovery Reform	-0.000835	-3.74e-05	-0.0525**
	(0.0362)	(0.00167)	(0.0259)
Contingency Fee Reform	-0.0237	0.00219	0.00219
	(0.0187)	(0.00153)	(0.00153)
General Surgery*Contingency Fee Reform	0.00208	-0.0283	9.13e-05
	(0.0260)	(0.0186)	(0.00127)
OB/Gyn*Contingency Fee Reform	0.00188	8.09e-05	-0.0285

	(0.0260)	(0.00127)	(0.0186)
Constant	0.179***	0.0457**	0.0457**
	(0.0625)	(0.0227)	(0.0227)
Observations	7,601	7,601	7,601
R-squared	0.410	0.516	0.515

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

is roughly -11,000, implying that OB/Gyn's premiums decrease by around $11,000 more than physicians in internal medicine when caps on noneconomic damages are enacted. Further, this coefficient is statistically significant at the 5% level. I also run the same IV regression omitting contingency fee reform in (2) and find that the estimates are relatively similar, importantly, the differential effect between OB/Gyn's and physicians in internal medicine is still statistically significant and economically important.

Next, I ran the same regressions using a log specification to test whether the same differential effects were observed in percentage terms. These two regressions are presented in columns 3 and 4 of Table 8, corresponding to the specification including contingency fee reforms and excluding contingency fee reforms, respectively. In (3) I find no evidence for differential effects of capping noneconomic damages between specialties; however, in (4) I find that physicians in internal medicine actually benefit more in percentage terms than surgeons and OB/Gyn's. While the percentage differences between physicians in internal medicine and surgeons and OB/Gyn's is only significant at the 10% level, it's nonetheless contrary to my hypothesis.

This second result is interesting because it diverges from the expectations of the model presented in the prior section. Before chocking this result up to insurance market imperfections, I propose an explanation for this phenomenon and a possible shortcoming of the model: the distributions of indemnity payments may be heterogeneous across specialties. Specifically, suppose that surgeons and OB/Gyn's have normally distributed indemnity payments whereas physicians in internal medicine have slightly more bi-modal distributed indemnity payments (note that their averages must still be roughly identical).

This explanation makes some intuitive sense, physicians in internal medicine have a lower probability of being sued for malpractice, and as such it's likely that in the event that they are sued, they may have committed a particularly egregious mistake more of the time than a surgeon or OB/Gyn. If this is in fact the case, reform measures limiting damages would have greater effects for physicians in internal medicine than predicted by the model (relative to surgeons and OB/Gyn's). If this is in fact the case, the observed results that, in percentage terms, premiums for physicians in internal medicine decrease more than premiums for OB/Gyn's and surgeons seems plausible.

Table 8 – IV Estimates

VARIABLES	(1) Premium	(2) Premium	(3) LogPremium	(4) LogPremium
Noneconomic Damages Cap	-7,912***	-6,038***	-0.436***	-0.520***
	(1,559)	(1,308)	(0.0680)	(0.0724)
General Surgery*Noneconomic Damages Cap	-687.3	-2,174	0.0809	0.162*
	(3,951)	(3,562)	(0.0896)	(0.0965)
OB/Gyn*Noneconomic Damages Cap	-11,138**	-11,898**	0.117	0.200*
	(5,280)	(4,869)	(0.0979)	(0.106)
Constant	43,045***	37,640***	2.682***	2.558***
	(2,761)	(2,827)	(0.639)	(0.640)
Observations	7,583	7,583	7,583	7,583
R-squared	0.525	0.528	0.678	0.674

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Finally, I both exclude contingency fee reforms as an instrument and restrict the sample only to states that prohibit insuring punitive damages. The results for the level (1) and log (2) specification are presented in Table 9. In (1), OB/Gyn's benefit roughly $47,000 more than physicians in internal medicine in response to capping noneconomic damages. Further, this difference is highly statistically significant. Again, however, the effect of noneconomic damage caps is roughly the same (or slightly less for surgeons) in percentage terms. Lastly, I test the overidentifying restrictions: for (1) $\chi^2(6) = 74.512$, p = .00, and for (2) $\chi^2(6) = 65.626$, p = .00.

Table 9 – IV Estimates

VARIABLES	(1) Premium	(2) LogPremium
Noneconomic Damages Cap	-29,844***	-1.858***
	(4,599)	(0.137)
General Surgery*Noneconomic Damages Cap	-2,651	0.335*
	(8,171)	(0.183)
OB/Gyn*Noneconomic Damages Cap	-46,994***	0.128
	(10,938)	(0.177)
Constant	113,037***	10.47***
	(7,614)	(2.389)
Observations	3,145	3,145
R-squared	0.408	0.543

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Critically, using premiums at the firm level as the dependent variable and using premiums at the state average level yield highly similar results.

5.3 Discussion of Results

In support of my hypothesis, I find that in levels premiums decrease in response to caps on noneconomic damages more for OB/Gyn's, a relatively high risk specialty, than for physicians in internal medicine, a relatively low risk specialty. This finding is fairly robust to specification as this result holds true using both firm level premiums and state average premiums as the dependent variable. Further, the result holds excluding contingency fee reforms as an instrument and by restricting the sample to only states that prohibit physicians insuring themselves against punitive damages. In the case of the restricted sample we know that caps on punitive damages and punitive evidence reforms are purely representative of the tort reform climate as legislators will not pass these reforms in an effort to reduce premiums; the fact that the results do not change with this restricted sample is therefore evidence that both punitive evidence reform and caps on punitive damages are, in fact, valid instruments.

In further support of my hypothesis, I find that, in percentage terms, premium decreases in response to caps on noneconomic damages for OB/Gyn's and surgeons, both high risk specialties, are not statistically different than the corresponding decreases for physicians in internal medicine. This finding is also consistent with the predictions of the model presented in Section 3. However, under some specifications, I find that premiums actually decrease more in percentage terms for physicians in internal medicine than for OB/Gyn's and surgeons. I surmise that these departures from the model's predictions may occur due to different distributions of indemnity payments for physicians in these various specialties.

5.4 Limitations

There are a number of limitations to this study; I will briefly discuss a few of them here. The first limitation is the model specification. The ideal specification to test the hypothesis would be to use a panel dataset and look at the effect of changes in laws on the premium difference by specialty. However, this is not possible for two separate reasons: 1) it likely takes insurance companies more than a year to accurately gauge (and reflect in offered premiums) the actuarial effects of a given reform measure[10], 2) a lack of within-state variation. The total number of changes in laws around caps on noneconomic for the sample period of 1993-2004 is less than 30. This lack of within-state variation also prohibited the use of state fixed-effects in the instrumental variable specification[11]. The second limitation is the fact that we cannot account for differences within a specific law type, for example all caps on noneconomic damages are coded equivalently (as dummy variables equal to 1) whereas the size of the specific cap can vary somewhat widely by state, ranging from $250,00 to $690,000 during the time period from 1993-2004. Similarly, different forms of contingency fee reform and punitive evidence reform are not accounted for in the data. I don't take these differences into account, a potential shortcoming of my model.

[10] In his database of state law tort reforms, Avraham (2011) does not consider reforms that were overturned within three years of enactment.

[11] However, as argued above, I don't see this lack of state fixed-effects as biasing my analysis.

6. Conclusion

This paper investigates the effects of capping noneconomic damages, a liability-limiting tort reform measure, on malpractice insurance premiums for physicians in different medical specialties. After providing a theoretical basis for my hypothesis, I test for differences in premium changes in response to enactment of noneconomic damage caps. Specifically, I instrument noneconomic damage caps with other non-liability limiting tort reform measures to measure the effect of damage caps in the absence of political pressure to reduce physician liability.

I find evidence to support my hypothesis that, in levels, medical malpractice premiums for physicians in high risk specialties decrease more in response to enactment of caps on noneconomic damages than do premiums for physicians in low risk specialties. Further, I find some evidence to support my hypothesis that, in percentage terms, premium decreases in response to enactment of noneconomic damage caps should be roughly equivalent across specialties. Hence, in response to caps on noneconomic damages, premiums decrease by a constant percentage for all physicians; however, this percentage decrease corresponds to a larger decrease, in dollar terms, for physicians in high risk specialties because their premiums were higher to begin with. Under some specifications, I find that, in percentage terms, premiums actually decrease more for physicians in internal medicine, a relatively low risk specialty, than for OB/Gyn's and surgeons, relatively high risk specialties. While this result is only weakly statistically significant, I surmise that this difference arises from differences in distributions of indemnity payments by physician specialty.

Understanding the extent to which physicians of different specialties differentially benefit from liability-limiting tort reform measures not only provides a deeper understanding of the workings of the medical malpractice insurance market, but also offers insight into why physicians of different specialties might be differentially incentivized towards inciting and supporting tort reform.

Variable Descriptions

Variable	Description
Premium	The premium charged, by a given firm for a particular state, region, and specialty for a policy offering $1 million in coverage per incident and $3 million in coverage per year.
AvgPremium	AvgPremium is the arithmetic average of Premium for a given state and year.
Specialty	Specialty describes to whom a given premium is offered. Specialty takes on three values: OB/Gyn, General Surgery, or Internal Medicine.
Noneconomic Damages Cap	Noneconomic Damages Cap is equal to 1 if a state has enacted caps on noneconomic damages and 0 otherwise.
Punitive Damages Cap	Punitive Damages Cap is equal to 1 if a state has enacted caps on punitive damages and 0 otherwise.

Split Recovery Reform	Split Recovery Reform is equal to 1 if a state has enacted split recovery reform and 0 otherwise.
Punitive Evidence Reform	Punitive Evidence Reform is equal to 1 if a state has enacted punitive evidence reform and 0 otherwise.
Contingency Fee Reform	Contingency Fee Reform is equal to 1 if a state has enacted contingency reform and 0 otherwise.
Population	Population of a given state.
Hospitals	Number of hospitals in a given state.
Admissions	Number of hospital admissions in a given state.
Births	Number of recorded births for a given state.
Surgeries	Number of surgeries performed in a given state
Average State Income	Average personal income for a given state.

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